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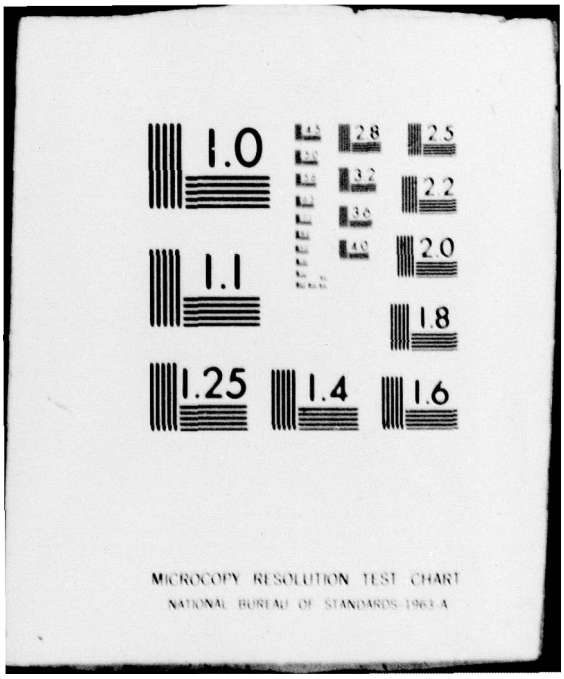
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AUTOMATIC URINE SUGAR ANALYSIS

By

A. Dempe and N. Beeke

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AUTOMATIC URINE SUGAR ANALYSIS

Authors: A. DEMPE and N. BEEKE .

In routine investigations at clinical-chemical laboratories, we are more and more encountering the situation where it is necessary to perform the same operations for a large number of identical samples.

This tendency and the already achieved status leads one to the requirement for automation of the analysis or measurement process. In this way, qualified workers can be made available for other tasks and automatic measurement methods are as a rule faster. The measurement results usually are more acurate and have better reproducibility.

An automatic Polarimeter, the POLAMAT S, has been developed which can also be used for determining urine sugar. Such a device has been used in our laboratory for about one and a half years. In the following we will discuss the experiences we have had with the POLAMAT.

Description

The POLAMAT is an automatic routine Polarimeter which is completely automatic and allows adjustment of the measured value very rapidly. It is made in two models by the VEB Carl Zeiss in Jena.

The POLAMAT A is a unit for general polarimetric angular measurements for different wavelengths. The device has a second scale (international sugar scale divided into degrees S), and therefore can also be used for determining urine sugar.

Even though the POLAMAT S is designed for special requirements of the sugar industry, it can also be used in a clinical laboratory.

Our experiences which we have collected with a prototype of the type

Clinic for diabetes and metabolism illnesses (Chief Physician: MR Dr. A. Dempe) of the Karl-Marx-Stadt Regional Hospital (Director: MR Dr. K. Emmrich)

POLAMAT A can immediately be transferred to the POLAMAT S. POLAMAT S is characterized by compact design (without additional power supply units). It only has an on/off switch and an adjustment knob for adjusting the zero point and it only has to be checked at large time intervals. In order to determine urine sugar the special polarimeter tube HB made of PVC is placed into the tube receptacle. It has a filling funnel fixed to the tube and an emptying port. The hose attached to the emptying port is directed outwards through the sampling space using a tube which connects with the back wall of the sampling space. It emerges from the back of the unit, so that there are no interferring hoses in the working area (Figure 1).

The samples are simply supplied by pouring the sample from the sample vessel. At the same time the measured sample is displaced and the tube is rinsed, so that no water jet pump or any other suction device are needed. The length of the polarimeter tube HB is such that the glucose concentration is indicated in grams/100 ml on the linear scale.

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The measurement accuracy is 0.03%. The measured value is automatically adjusted and occurs at such a fast rate (see below) that in practice the measurement result is already indicated as soon as the sample has been exchanged. This means that the operator only has to add the sample and write down the measured result.

Sampling Result

In order to establish the time savings connected with the use of the POLAMAT for urine sugar determination, we have carried out measurements with this unit the circular polarimeter with the conventional polarimeter tube, as well as the curcular polarimeter with the polarimeter tube H. Clear urine from which albumin has been removed was used for the investigation. As far as the removal of the albumin is concerned we would like to point out that if this is not performed, measurement errors occur. About 10-15 ml of sample is required for the measurement process in order to compare the methods. This amount is sufficient for the POLAMAT in order to exclude disturbing mixing effects when the

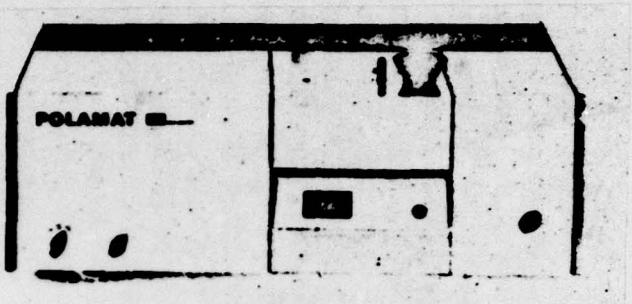

Figure 1. POLAMAT A with Polarimeter Tube HP in the Operational State (in the POLAMAT S, the right and left wavelength switches are missing)

sample runs through during the determination of urine sugar in the device.

In order to measure with the circular polarimeter using a closed polarimeter tube, we found that the average time expended was 40 seconds. On the other hand there was a substantial time savings when using the circular polarimeter with the polarimeter tube H; here the determination was carried out in 14 seconds on the average. In the case of the POLAMAT, the analysis duration is given at between 4 and 5 seconds by the manufacturer. Over long test periods we found that the adjustment time is really 2.5 seconds.

According to the instructions, fast adjustment time is guaranteed up to a 1% light penetrability. In the case of cloudy urines, there is a substantial lengthening of the analysis duration, up to about 25 seconds. The results determined for this case should not be accepted uncritically because of the falsification by the albumin and because of the influence of the degree of polarization caused by scattering effects. This was already discussed above.

In the examination of the measurement accuracy with standarized glucose solutions, we were not able to find any deviations in the individual work processes when using the POLAMAT for one year. This advantage of constant measurement accuracy compared with a subjective influence on the measurement result by the technician in the visual determination using the circular polarimeter must be stressed. Especially for long measurement series there can be fatigue phenomena of the female technicians which can then result in measurement errors.

The automatic urine sugar determination brings about an improvement in the reproducibility of the measurement results. The POLAMAT was filled with standard glucose solutions at intervals of two hours. We were able to determine that for the same external conditions we obtained identical results. The concentration of the specimen liquid of urine being determined or the standardized glucose solution had no influence on the reproducibility which is better than 0.05%. In the case of visual determination using the circular polarimeter which was carried out by a medical-technical assistant, the results are also very well reproducible. However if the investigation is carried out by several persons, the reproducibility has large errors caused by the different sensations of color brightness of the human eye.

We should also mention the cleanliness involved when working with the samples using the POLAMAT. The female assistants practically do come into contact with the urine. The device operates without any disturbing noise loads. Maintenance is reduced to a minimum. The polarimeter tube only has to be cleaned at regular intervals. During previous experiences there were no technical difficulties at all.

Discussion

In our clinic for diabetes and metabolism illnesses as well as at the next door center for diabetes and metabolism illnesses, over 1,000 urines have to be investigated everyday. When measurements are

carried out with the circular polarimeter and the normal polarimeter tube, about 11 hours of work are required. When the circular polarimeter is used with the polarimeter tube H, about 4 hours are required. If the POLAMAT is used, about 0.7 hours are required. When the polarimeter tube H is used, there is a time savings compared with the normal polarimeter tube of about 7 hours. If the urine sugar is determined automatically using the POLAMAT, about 10 hours are saved. This means a substantial gain in working time for the medical-technical female assistants. Rost [3] states that the automatic device made by the Hilger I.R.D. Ltd., London requires 7.4 seconds for an investigation. Compared with this, the substantially shorter analysis duration of the POLAMAT made by the VEB Carl Zeiss is substantially better. The dimensions of the POLAMAT (800X400X250mm) mean that the device can be placed on a normal work table in a normal laboratory. Comparable analyses of automatic devices such as the one from Hilger have much larger dimensions. The simple operation of the automat means that trained female laboratory assistants can be used on the POLAMAT. The same reproducibility of the results was found. This means that it is no longer necessary to use a qualified female medical-technical assistant for determining urine sugar if the POLAMAT is used.

In constrast to clinical conditions where the results of urine investigations do not always have to be available immediately, under ambulatory conditions, the time required for the patients to wait for the investigation result could be very important. This is especially 328
true when many urines have to be investigated, which is always the case in the treatment of diabetes. We would like to indicate the economic importance of these related questions. However one condition for economic exploitation is that there be an automatic blood sugar determination in parallel with the determination of urine sugar using the POLAMAT.

Compared with earlier investigations in our clinic, we would especially like to point out that the POLAMAT does not have any load limitations. The urines which we process can be investigated at any time continuously. The reproducibility of the results achieved with the automatic device has an error which is less than 0.05%. This result can not be achieved with a continuous input to medical-technical assistants processing 1,000 urines a day and using visual methods. The high relative error

in the visual determination of the urine sugar, especially at low concentrations, is caused by the different color brightness sensations of the individual MTA. The error is reduced at higher concentrations. Rost [4] and Pense [3] reached a similar result. For glucose concentrations below 1.0g/100ml the visual polarimeteric determination seems questionable.

The automatic POLAMAT S routine polarimeter (VEB Carl Zeiss Jena) is of great value in rationalizing laboratory work. Its use is appropriate and economic if at least 500 urine specimens are analysed per day. In case of fewer samples, the circle polarimeter with the polarimeter tube H is indicated.

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